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Conservative management of the post-traumatic stiff elbow: a physiotherapist's perspective

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Abstract

Elbow stiffness is a common consequence following trauma with the management of this condition posing a challenge to therapists and surgeons alike. This paper discusses the role of conservative treatment, such as exercise and splinting, in the prevention and management of the stiff elbow, along with a review of available evidence, to justify their usage.

Keywords

conservative management, post-traumatic, stiff elbow

Introduction

The elbow joint functions as a link between the upper arm and the forearm. It positions the hand in space,[1] allows the forearm to act as a lever in lifting and carrying, and provides precision in both open and closed kinetic chain work. Therefore, even a mild restriction of elbow range can significantly reduce the ability of the hand to reach its objectives, with the problem being compounded by the fact that the other joints in the upper limb are unable to compensate for this loss.

Unfortunately, stiffness is a common clinical problem following elbow trauma,[2] as a result of the rigidity of the ulnohumeral joint, the presence of three joints in one synovial space, and the close relationship between the joint capsule, the intracapusular ligaments and the surrounding musculature. In particular, the brachialis muscle overlays the elbow joint capsule anteriorally and is a primary site for heterotopic ossification.

Elbow range of motion

The normal arc of motion at the elbow is up to 160° of motion in flexion and extension, and 75° to 80° of both pronation and supination, However, with some restrictions in elbow range, individuals can still achieve full function. A study by Morrey et al.[3] in 1981 found that the functional range in which most activities of daily living can be accomplished is 30° to 130° of flexion/extension and 50° each of pronation and supination. This functional range has been quoted extensively in the literature, and is often the target that therapists and surgeons use to determine whether an intervention has been deemed successful. However, more recently, Sardelli et al.[4] concluded that functional range of motion may be greater than that reported previously by Morrey et al.[3]. Contemporary tasks such as the use of a computer mouse or keyboard, and the use of a mobile phone, appear to require more than 50° of pronation and 130° of flexion respectively. Therefore, functional range should be determined on an individual basis, depending on a patients occupational and sporting demands and hand dominance. This should be considered when designing rehabilitation programmes for patients.

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Stiffness is the most common clinical problem after elbow trauma, with loss of elbow extension up to 30° being the most common outcome.[2] This deficit in range is usually well tolerated; however, in contrast, loss of flexion significantly affects function because the hand is unable to reach the head and mouth.[2] The deficit in flexion cannot be overcome with compensation at other joints, with up to 12% of all elbow fractures and dislocations developing a limitation in flexion that requires surgical intervention.[5]

This review focuses on the assessment and physiotherapy management of post-traumatic elbow stiffness and presents a guide for the conservative management of this condition

Classification

The pathoanatomy of elbow stiffness has been classified based on its aetiology and anatomic location. Morrey's three-part system classifies elbow stiffness as extrinsic, intrinsic or mixed.[6] Intrinsic stiffness refers to intra-articular incongruity or adhesions, loose body osteophyte formation or malalignment of the articular surfaces. Extrinsic refers to stiffness as a result of extra-articular factors such as capsular collateral ligament and muscular contraction, as well as heterotopic ossification. However, subsequent to significant trauma, extrinsic factors can follow intra-articular fractures, and the presentation is usually a mixed one. This classification system offers little in terms of the management or prognosis of these conditions and therefore is of limited value when assessing an individual's injury.[2]

Clinical examination of the elbow

A careful history is essential to establish an accurate diagnosis, as well as to gather sufficient information about an individual to allow a safe, effective and efficient physical examination. The following points need to be considered.

Age and hand dominance

Age may influence expected or realistic goal setting because elbow range decreases with age.

History of injury, subsequent management and complications

Following trauma, an attempt should be made to define the mechanism of injury as accurately as possible because such information may reveal patterns of injury that involve particular structures within the elbow, and may help inform therapists regarding safe zones of motion.

Degree, duration and progression of stiffness

As noted previously, better results with conservative management are achieved when interventions are initiated at an early stage because the first 6 months after injury represents the critical rehabilitation period. Giannicola et al.[7] report that 70% of patients recovered functional range between 3 months and 6 months post injury, with recovery of flexion being slowest to improve. Thereafter, improvement occurred at a slower rate, until 12 months post injury, when 80% of patients had recovered functional range.

Impact of stiffness on activities of daily living

The impact of motion loss on occupational and recreational pursuits should be established to determine the level of demand placed on the elbow.[2] Appreciating the impact of the disorder on an individual's function and life is paramount in treatment planning. Distress and an inability to work can prove barriers to treatment compliance,[8] whereas determining a patient's expectations and beliefs has been shown to be an instrumental part of establishing a therapeutic relationship, affecting outcomes.[9,10]

Pain, nature and behaviour

It is important to qualify the nature of an individual's pain, including its quality and behaviour in different scenarios and over a 24-hour period.[2] Frequency and dosage of analgesia and other medications may help the therapist establish the severity of a patient's pain. Developments in our understanding of pain emphasise the importance of considering peripheral, central, autonomic and psychosocial influences upon a patient's presentation, which will have a direct impact on rehabilitation options chosen.[11]

Neurological symptoms

This includes the presence of neuropathic pain, weakness, clumsiness, parasthesia or anaesthesia.

Locking or mechanical symptoms

These may occur as a result of loose bodies.[2]

Physical examination

Observation

Any deformity, muscle wastage, previous scars, prominent metalwork, along with oedema, colour changes and trophic changes in the elbow, forearm and hand, should be noted.[2]

Palpation

The elbow is largely subcutaneous and the bony anatomy can be easily palpated for abnormalities.

Range of motion

Passive and active range for flexion and extension, pronation and supination should be examined. Range of motion can be measured with a long arm goniometer. However, a significant inter-observer error of almost 10° (of both flexion and extension) has been observed when measuring elbow range in this way.[12] This raises the possibility of some clinical trials overstating claims of effectiveness for a particular treatment.[2]

Passively, the character of the end feel at extremes of motion should be noted, with changes in what is considered normal being noted. A hard end feel +/− pain suggests a bony block to motion, whereas a softer end feel may be indicative of soft tissue contracture.[1] Crepitus appreciated during movement may signify degenerative changes or an non-united fracture, whereas restriction of forearm motion with a positive grip and grind test, where the forearm is axially loaded and rotated, may be a result of radiocapitellar joint pathology.[2]

Passive motion also allows the therapist to try and differentiate between joint and muscle length contributions to elbow range. A difference in elbow extension range with the forearm in pronation and then supination may signify a decrease in biceps length.

Figure 1. Transverse accessory mobilization of the ulna.

Accessory joint motion

These are defined as those movements that a person cannot perform actively but which can be performed on that person by an external force.[13] They allow physiotherapists to assess the range and quality of movement at the elbow joint (Fig. 1). Physiological motion restriction may be as a result of limitation of accessory range of motion. Therefore, positive findings can be used to formulate a treatment plan.[14]

Neurovascular assessment

Particular attention should be paid to the ulna nerve because it is commonly injured during elbow trauma.[1] Assessment should include the presence of allodynia, hyperpathia, changes in pain pressure thresholds and the presence of cold hyperalgesia. Changes in pain pressure threshold may indicate a central pain component,[15] whereas cold hyperalgesia may indicate an autonomic component.[16] Sensory testing should include stereognosis testing and two-point discrimination testing.[17] Normative data for two-point discrimination in the upper limb, as stratified for hand dominance and sex, are available to clinicians.[18]

Upper limb neural dynamic testing should be considered where neural involvement is suspected.[17]

Review of other investigations

Imaging of the patient with a stiff elbow should include plain films including both anteroposterior and lateral views.[2] This can help clarify bony causes of motion restriction, including osteophytes, loose bodies, the presence of heterotopic ossification, non- or malunions and erosions. This will help inform the therapist regarding the likely outcome of conservative management. Also, the results of nerve conduction studies, undertaken in the presence of neurological dysfunction, should be available for review, to inform decision-making regarding treatment and prognosis.

Following the assessment, time should be available to formulate a treatment plan with the patient, with agreed goals and appropriate realistic timescales for any change to occur. It is recognised that most patients are concerned about a lack of extension; however, from a functional point of view, this may not be a priority because a lack of flexion usually causes most functional losses. It is important to explain this to patients when setting treatment priorities.

Conservative management of the post-traumatic stiff elbow

The goal in treating patients who sustain an elbow injury is to provide the patient with a pain-free, stable functional elbow. According to Wilk,[19] rehabilitation prevents the deleterious consequences of immobilization and avoids excessive stress on healing tissues. Patients should meet defined clinical criteria before progressing from one rehabilitation stage to the next, with therapists basing programmes on evidence that should be individualised to the patient and their specific needs. Chinchalkar[20] proposes a five-step rehabilitation process that involves the correct diagnosis, control of pain and inflammation, early protected motion, neuromuscular control and integration of motion into the whole kinetic chain. Non-operative treatment options available to physiotherapists to achieve these goals include active exercises, passive mobilizations, the use of continuous passive motion machines and splinting. All of the above need to occur with as little as discomfort as possible because pain can be a contributory factor in the development of post-traumatic elbow stiffness

Pain and elbow joint motion

Anecdotally, patients who develop heightened experiences of pain during the early stages of rehabilitation, or sustain nerve injuries are more prone to developing joint contractures.[21] This leads to the hypothesis that neuroinflammatory mechanisms contribute to the process of fibrosis. Following injury, neuropeptides such as substance P and calcitonin gene-related peptide are synthesised in the dorsal root ganglion and are secreted by peripheral nerve endings in tissues such as the elbow ligaments and capsule. Substance P stimulates fibroblast proliferation, impairing aptosis signalling in myofibroblasts and leading to proliferation of myofibroblasts in the elbow joint capsule, which remains unchecked.[22,23] Elbow joint motion has been shown to be inversely proportional to the number of joint capsule myofibroblasts.[24] The equilibrium between matrix synthesis and remodelling is lost or never established, and the connective tissue healing response becomes maladaptive.[21] Therefore, it can be seen that pain may be the trigger for the cascade of events causing elbow joint contractures. Physiotherapists should therefore recognise the importance of pain control during all forms of conservative treatment discussed below, so as not to exacerbate the very condition that they are trying to treat.

Active exercises

These are used by the vast majority of therapists,[25] with early mobilization advocated by a number of studies aiming to reduce the effect of immobilization on the capsule, ligaments, muscles and osteochondral tissues.[26] Early mobilization also helps prevent oedema and an increase in viscosity of imflammatory exudates, which may predispose the joint to adhesion formation.[11] However, although experts appreciate and acknowledge the importance of early mobilization, it is not common practice worldwide. In a previous European study,[27] more than 60% of patients sustaining a simple elbow dislocation were treated with plaster immobilization for at least 3 weeks, with surgeons fearing instability with early active motion. However, there is little evidence to support this view. In a review of simple elbow dislocations, Harding et al.[28] highlighted early mobilization at 3 days post injury, which resulted in an improved range of motion with no increased risk of complications, including instability compared to the immobilization group, at 12 months follow-up. These differences in range failed to reach statistical significance. The multicentre FuncSie trial[29] showed early mobilization post dislocation resulted in an earlier return of functional range and return to work, again with no increased risk of complications and no differences between groups at 1 year follow up.

The overhead position described by Wolff and Hotchkiss[30] is the optimal mobilization position to achieve early mobilization. This position has been demonstrated to maximise elbow stability, by minimizing ulnohumeral distraction.[31] Distraction is most marked with the arm hanging dependent by the side, especially when wearing a cast or hinged elbow brace, and so this position for exercises should be avoided in the early stages of rehabilitation.[31] The overhead position also has the added benefit of minimizing biceps electromyographic activity seen clinically in the painful stiff elbow.[32] It also enhances triceps activity, thereby maximizing elbow extension range.[32] This position is suitable for the majority of individuals with conservatively managed elbow pathology. However, in post-operative patients, it is only suitable where a triceps sparing approach has been taken. This position also minimises the varus strain on the elbow,[33] which occurs when mobilizing the elbow in the sitting position, with the shoulder abducted and internally rotated, which may place undue stress on the lateral stabilisers of the elbow.

Initially, active assisted flexion/extension is performed with the contralateral upper limb providing support where needed. The forearm position during this exercise is dictated by the capsulo-ligamentous structures that need protecting. With lateral compartment lesions, the forearm is placed in pronation, where passive tension in the common extensor origin contributes to lateral stability. It therefore follows that, with medial compartment lesions, exercises are performed in supination, and stability is afforded by passive tension in the common flexor origin. Exercises are progressed to active movements without assistance as soon as comfort allows, with exercises performed in a protected range as defined by the nature of surgery or injury (Fig. 2). They must be performed frequently throughout the day and involve all planes of elbow, forearm and wrist motion. Rehabilitation programmes should include active mobilization because studies show muscular activation stabilises the elbow.

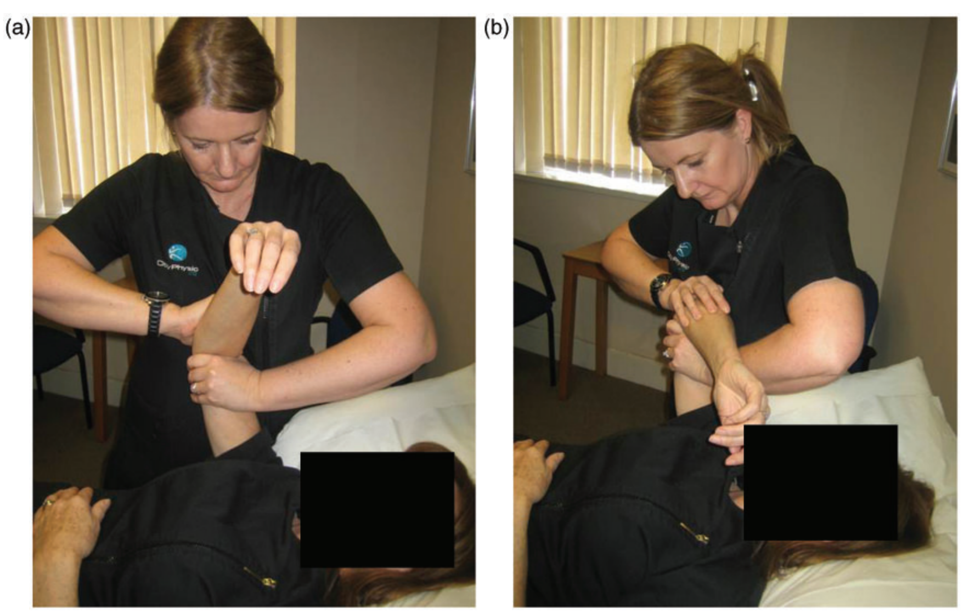
Following injury, cortical changes are seen in the corresponding sensory and motor cortices. To improve afferent input into this area, Fusaro et al.[26] suggest perceptive and proprioceptive rehabilitation, including neuro-muscular facilitation as well as the integration of elbow activity into the full kinetic chain. Gibson[11] describes close kinetic chain exercises as particularly useful early in the rehabilitation process as a result of their proprioceptive value and because they incorporate the whole upper limb. They can be utilised to enhance proximal stability at the glenohumeral and scapulothoracic joints, at the same time as facilitating appropriate stability strategies at the elbow.

Figure 2. The overhead mobilization position.

Passive mobilizations

These can include both accessory techniques and mobilizations with movement (MWM) described by Mulligan,[34] directed locally at the elbow or to remote joints, such as the cervical spine. Although clinically useful in improving range, they are used by less than one-third of physiotherapists in the early stages of rehabilitation,[25] and the evidence to support their use is lacking. MWMs are nonthrust mobilization techniques, where the therapist identifies a limited or painful motion.[34] The patient then actively repeats the motion at the same time as the therapist performs a gliding technique to the elbow. Examples of MWMs include lateral (Fig. 3a) or longitudinal (Fig. 3b) glides of the ulna, applied via the olecranon, at the same time as the patient performs active extension.

Initial hypotheses regarding the beneficial effects of MWMs focussed on their mechanical effects. However, their effects are much more likely to be the result of a complex multisystem physiological response.[15]



Figures 3a and 3b. Examples of mobilizations with movement performed at the elbow.

Vicenzino et al.[15] suggest that patients, whose elbow pain is characterised mainly by alterations in pain pressure thresholds, and where central pain mechanisms predominate, may benefit from MWMs directed at the cervical spine. This technique has been shown to have a direct effect on pain pressure thresholds, to improve range of motion during neurodynamic testing and to improve pain-free grip. MWMs may be a useful adjunct in treating the painful elbow at risk of developing stiffness, in situations where direct mobilization of the elbow is not appropriate (i.e. immediately after injury). The technique consists of the patient being supine, with the affected limb being supported by the trunk. Cervical glides are directed from the contralateral side towards the affected side. Mobilizations are performed slowly, in 1-minute sets, with several sets being performed in one treatment session, and with the number of sets being determined by symptomatic response to the treatment. Despite promising results being obtained using these techniques, the follow-up in these studies is extremely short, and there is the need for further examination in future trials.

Many assume that aggressive passive mobilizations can cause damage to the brachialis muscle and joint capsule, leading to heterotopic ossification and a mechanical block to motion. Heterotopic ossification commonly occurs around the elbow in response to trauma, with up to 3% of simple elbow dislocations and up to 20% of elbow fracture dislocations being complicated by its presence.[35,36] Anecdotal accounts of passive mobilizations causing this condition have controversially lead to a call for physiotherapists to avoid using passive mobilizations in the management of post-traumatic elbow conditions. Studies do suggest a relationship between forced movement and heterotopic ossification. Animal studies show the development of heterotopic ossification in joints that were taken forcibly beyond their available range of motion for 5 minutes daily, and then immobilised completely for the remainder of the day.[37] However, it is important to note that these forceful manoeuvres bear no resemblance to the passive mobilizations that therapists employ on a daily basis to treat post-traumatic stiffness. Consequently, there would appear to be no evidential basis to discontinue passive mobilizations in the treatment of a stiff elbow.

Botulinum toxin injections

Recently, the role of botulinum toxin A in preventing post-traumatic elbow stiffness in adults has been explored, following successful results in children. In patients undergoing internal fixation after fracture, intra-operative injection into the elbow flexors improved the range of motion and function.[38] Theoretically, these injections transiently limit activity of the flexor muscles and allow active triceps contraction, which may help facilitate gains in elbow range. More work is needed to determine the effectiveness of this technique, although it may prove to be a useful adjunct in rehabilitation, where increased muscular activity is considered to contribute to a restriction of range.

Continuous passive motion

Continuous passive motion (CPM) has been advocated to prevent tissue oedema by the squeezing effect of tissues, driving fluid away from the joint and periarticular tissues,[39] thus minimizing the cascade of events leading to soft tissue contractures. It is recommended that it is used as soon as possible, after injury or trauma, for long periods of time through the largest possible safe arc of motion. Patients may need satisfactory pain control in the form of patient-controlled analgesia or regional anaesthesia. Complications of this technique include increased bleeding and delayed wound healing, with some suggestion that the use of CPM machines exacerbates ulna nerve irritation. Although, theoretically, CPM would appear to be beneficial, there is little evidence to recommend its use. Retrospective case series to date report similar gains in the arc of flexion in patients with post-traumatic elbow stiffness with or without CPM.[40] Lindenhovius[41] found no difference at 1-year follow-up between patients, after open arthrolysis, between the CPM and no CPM treatment groups. In reality, the variety of surgical techniques, CPM machines and postoperative regimes, along with additional post-operative treatment and a lack of long-term follow-up, makes it difficult to compare CPM studies.[40]

Splinting

The key to the conservative treatment of the stiff elbow is the viscoelastic nature of connective tissue, which has the ability to respond with both elastic (temporary elongation) and plastic (permanent elongation) deformity to tensile loading.[42] Plastic elongation can be applied using manual techniques, although the use of splints has been described as being easier and more straightforward. Splinting has been suggested as a way to load tissues to increase range, in the absence of heterotopic ossification.

Initially, two types of splint have been described: static and dynamic. Static resting splints maintain the end point of either flexion or extension and operate upon the principle of creep loading (i.e. the use of a constant force resulting in varying displacement). These splints have to be worn for long periods of time during the day,[43] as well as at night, in the position requiring the most improvement in range.

Dynamic splints use the stress relaxation principle to increase range (i.e. constant displacement with variable force). Engineering models suggest stress relaxation leads to plastic deformation more quickly and reliably than creep. Dynamic splints typically use springs that need to be altered on a frequent basis as they lengthen. Again, these splints need to be worn for a considerable portion of the day. An extension of dynamic splinting is static progressive splinting, which uses the same type of splint as in dynamic bracing but with constant tension applied by the use of a turnbuckle.[2]

Patients may complain of pain during splint wear, probably as a result of the constant tension being placed upon soft tissues,[2] which may result in discontinued use. Gallucci et al.[44] advocate the use of very low forces during dynamic splinting, which are gradually increased within the limits of the patients symptoms. Using this approach, the soft tissues can be stretched over long periods of time, avoiding pain or spasm, which is counterproductive to rehabilitation and, as discussed earlier, may lead to an increase in stiffness

The general consensus is that the benefits of splinting are most notable in the first few months after injury,[43] although gains may be seen in adults up to 12 months after injury, as well as in children for even longer than that.[1] Post cessation of splinting, up to 10% of patients loose motion, whereas 10% develop a further increase in range.[42]

There is a paucity of trials addressing the effect of splinting, with most trials being small retrospective observational studies, with marked differences in the type of splints used and wear protocols. However, the outcomes of these trials appear to be fairly similar, with very little difference between the outcomes using any of the above devices. Average gains in arc of motion are approximately 30°, with an average use time of 3 months, and with low incidences of complications. Over 60% of patients using a splint regain functional motion.[44] However, it should be noted that the use of splints is not practical for everyone. Splinting is often time consuming. They require frequent readjustment and may limit an individual's capacity to work or take part in leisure activities

Conclusions

Most patients will achieve a functional range of motion within 12 months of elbow trauma. The simplest and safest options to achieve range should be chosen initially and, clearly, conservative management should therefore be the first choice of treatment. There appears to be consensus that this process needs to be started promptly to try and prevent joint stiffness, and that rehabilitation needs to be continued for a minimum of 6 months, aiming to afford changes in range. Only when a stiff elbow has proved to be refractory to long-term physiotherapy should surgical intervention be considered. There appears to be a paucity of evidence regarding conservative management options in the management of the stiff elbow compared to the body of evidence concerning surgical release. This is surprising because conservative management should be tried routinely before surgical release of the stiff elbow is attempted, as surgery carries significant risks of post-operative complications. Future research should focus on comparing the results of conservative versus operative intervention, including patient satisfaction rates.

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